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U1S S1714 S1720 S1931 S2188

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GB 2023899 A GB 1595796 A GB 1207201 A

(58) Field of search
UK CL (Edition J) G4H HRBE HRBS HTG
INT CL⁴ G08C

# (54) Remote control systems

(57) A remote control system has transmitters (1) sending messages including commands to a security receiver (2) arranged to verify those messages on the basis of identity codes in the messages and to execute the commands, such as issuing an alarm and turning a light on or off. The codes are stored in memory (7, 15) in the transmitters (1) and receiver (2) and are generated as random numbers in the transmitters and transmitted to the memory (15) of the receiver (2) in an installation mode.

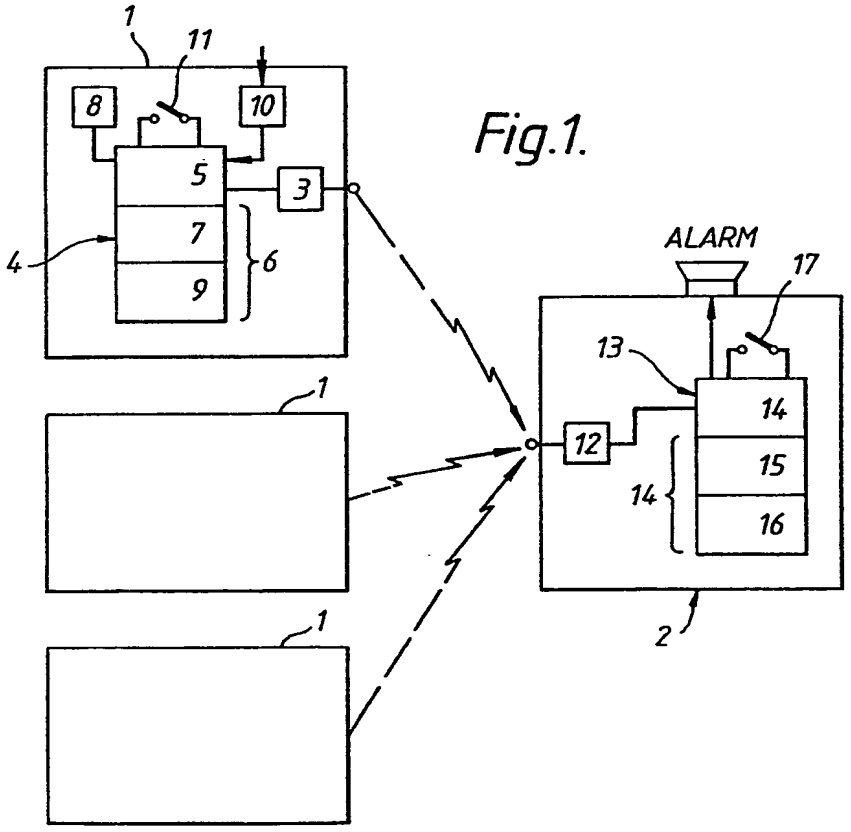


Fig.1.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

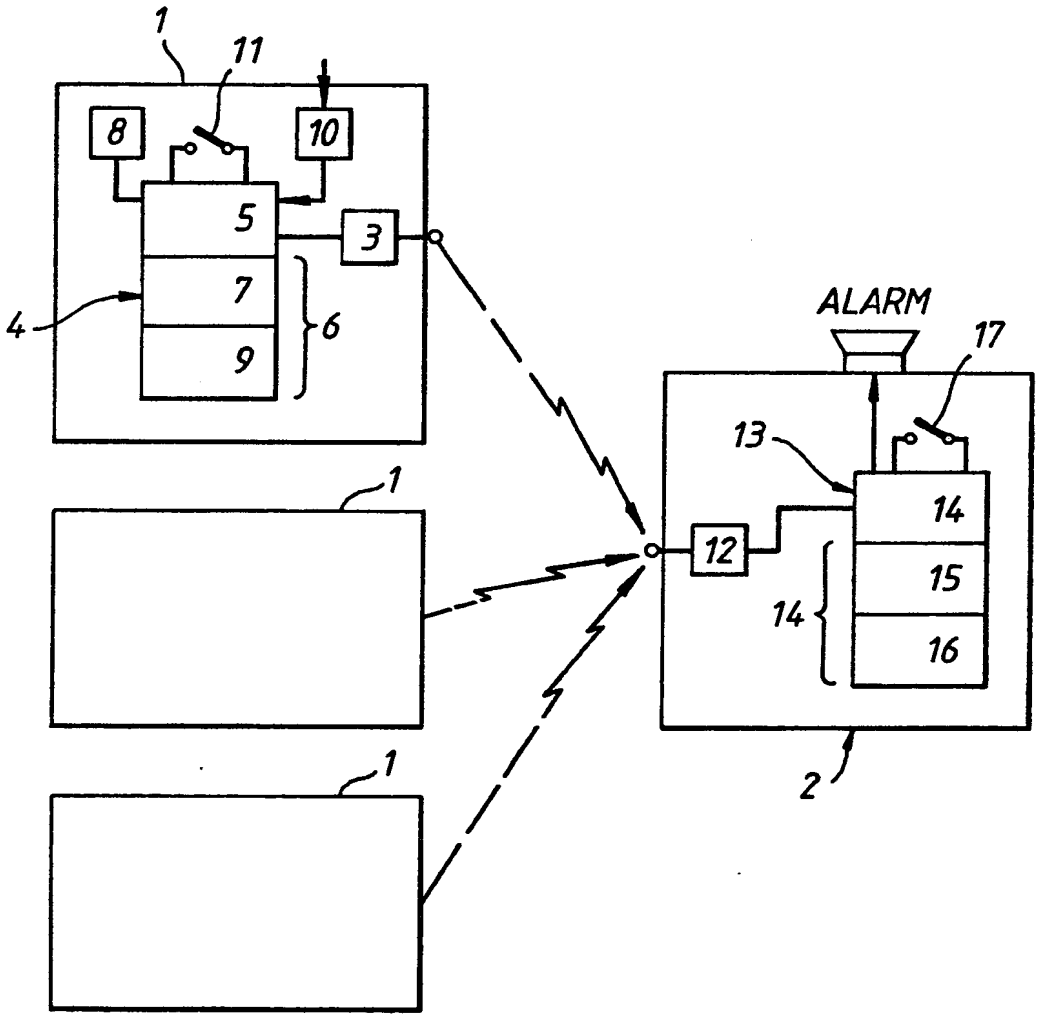


Fig.1.

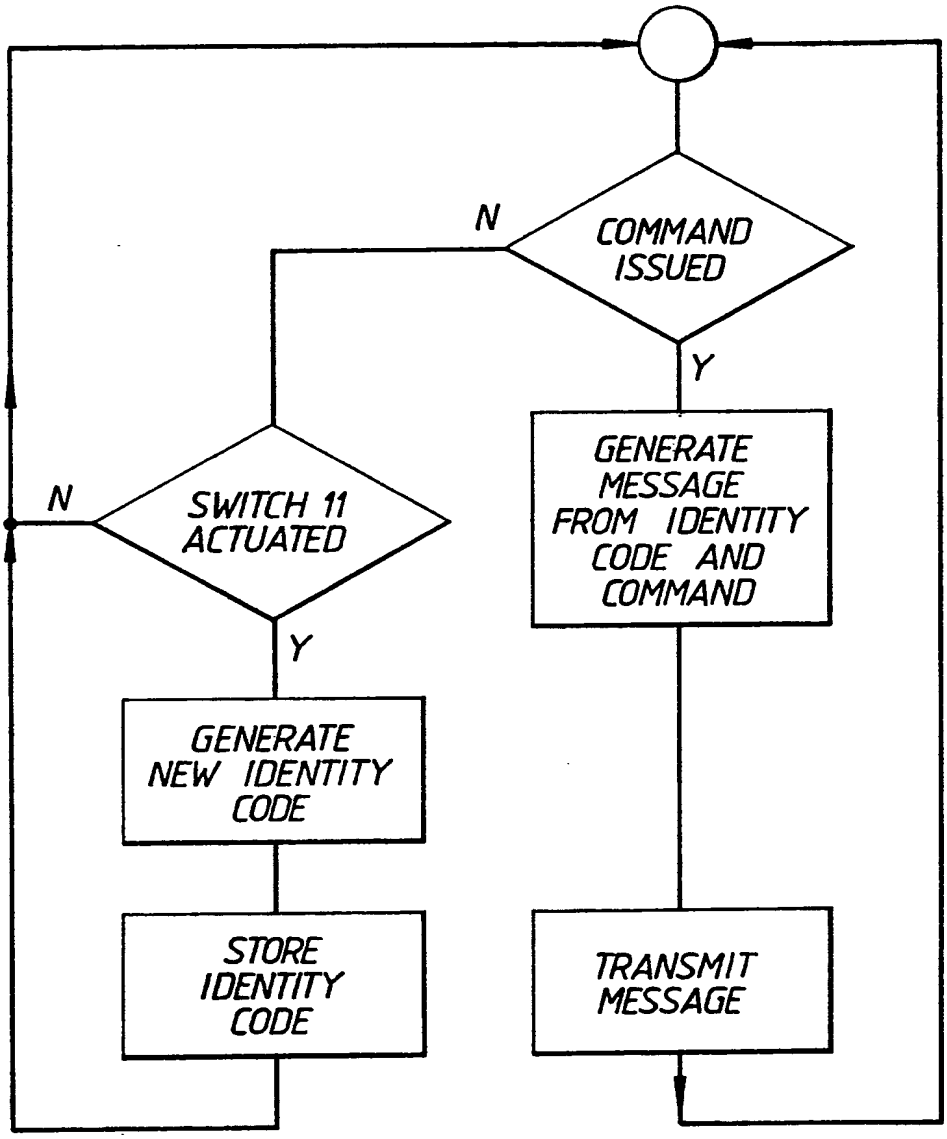
COMMAND ISSUED
N
Y
GENERATE MESSAGE FROM IDENTITY CODE AND COMMAND
SWITCH 11 ACTUATED
N
Y
GENERATE NEW IDENTITY CODE
STORE IDENTITY CODE
TRANSMIT MESSAGE

Fig. 2.

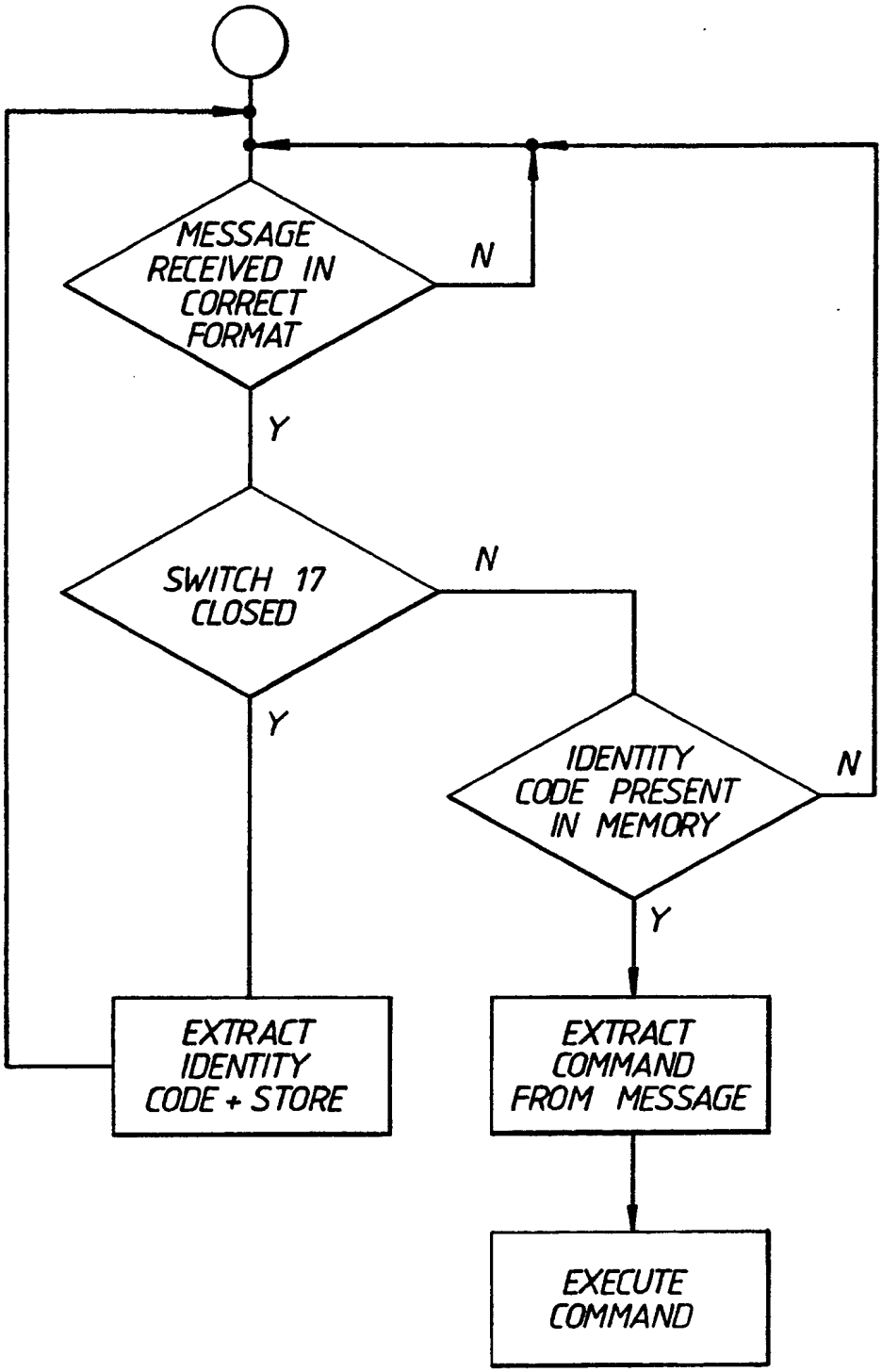
MESSAGE RECEIVED IN CORRECT FORMAT
N
Y
SWITCH 17 CLOSED
N
Y
IDENTITY CODE PRESENT IN MEMORY
N
Y
EXTRACT IDENTITY CODE + STORE
EXTRACT COMMAND FROM MESSAGE
EXECUTE COMMAND

Fig.3.

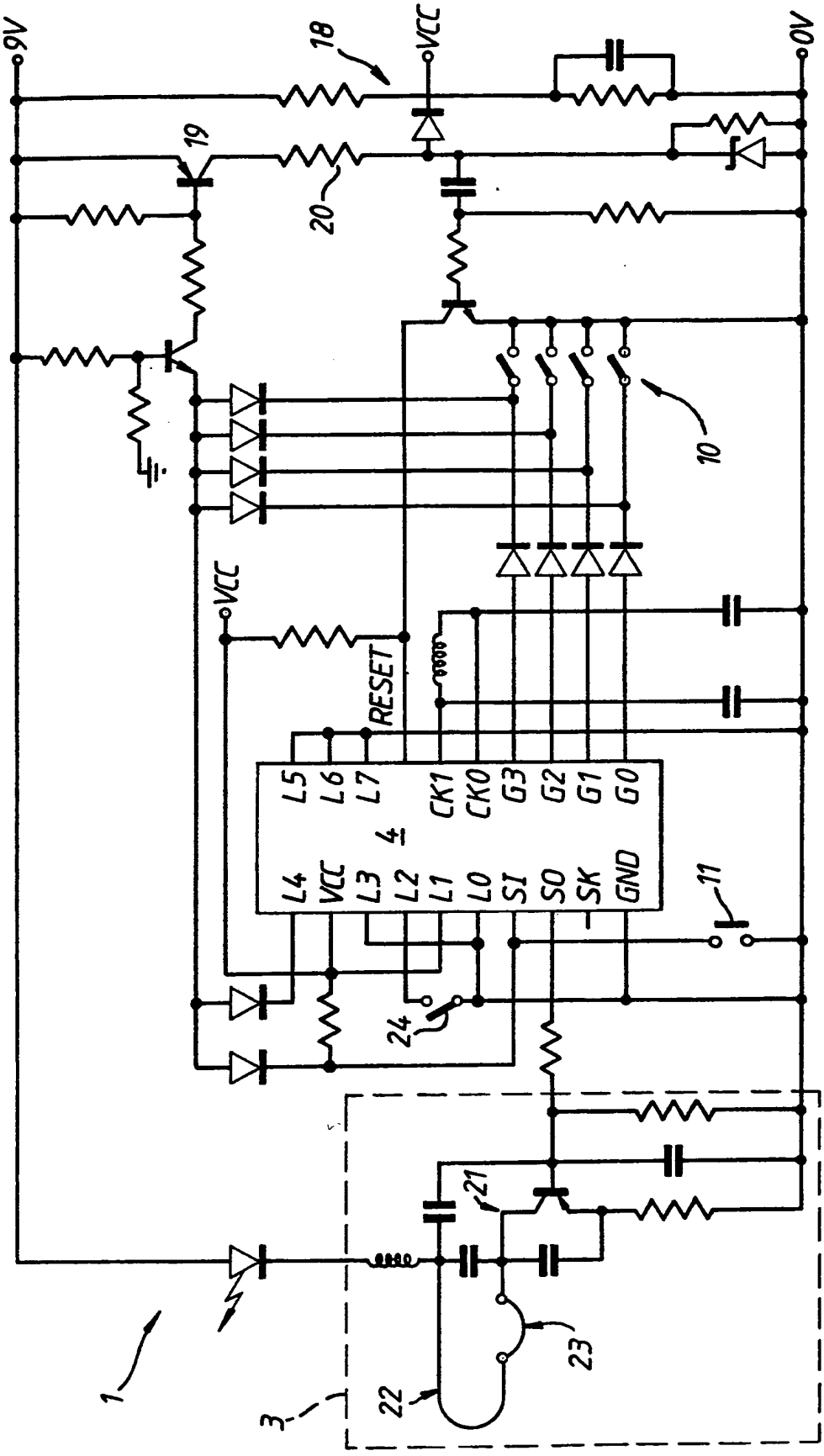
9V
18
VCC
0V
19
20
10
VCC
RESET
L5
L6
L7
CK1
CK0
G3
G2
G1
G0
4
L4
VCC
L3
L2
L1
L0
SI
SO
SK
GND
11
24
21
23
22
1
3

Fig.4.

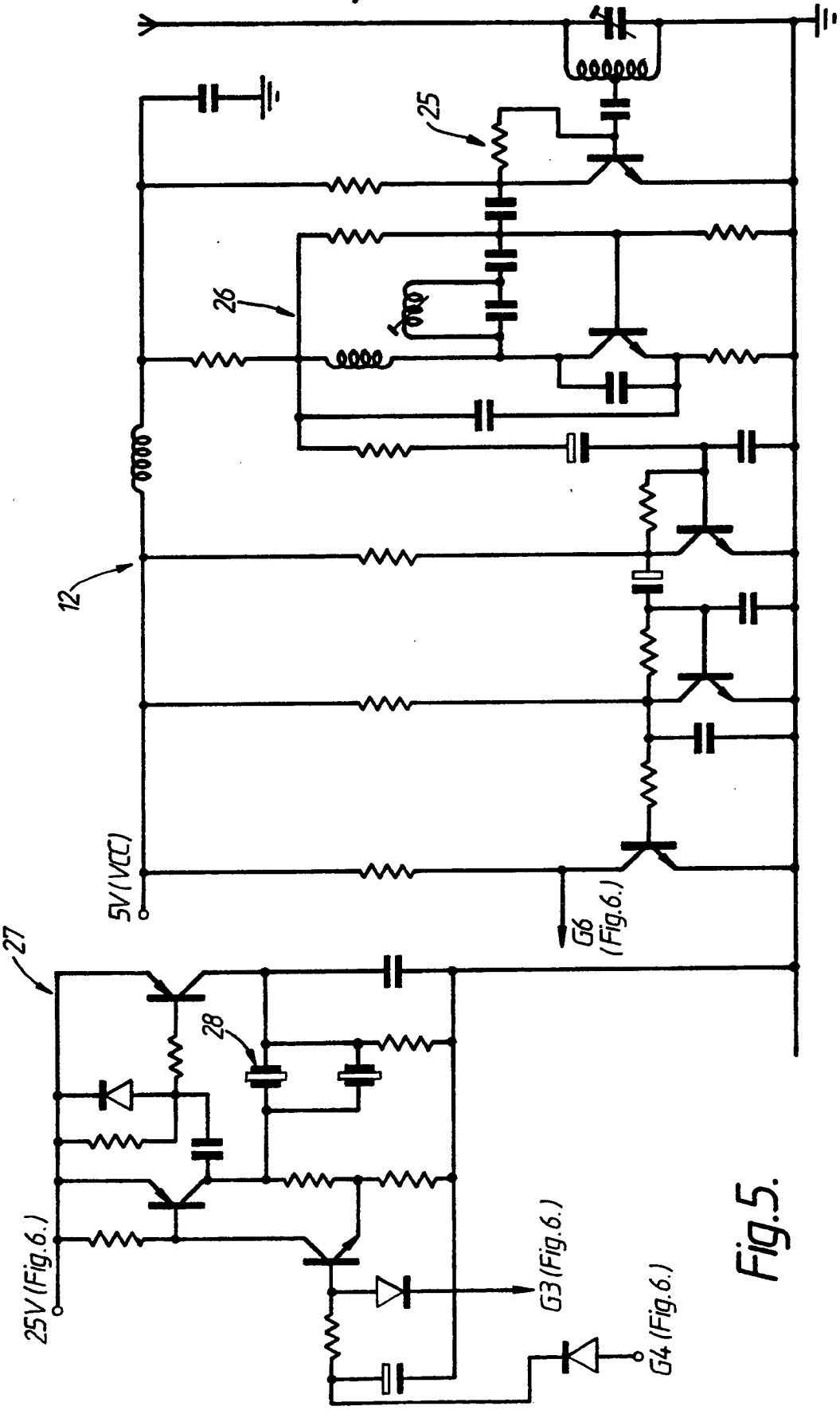


Fig.5.

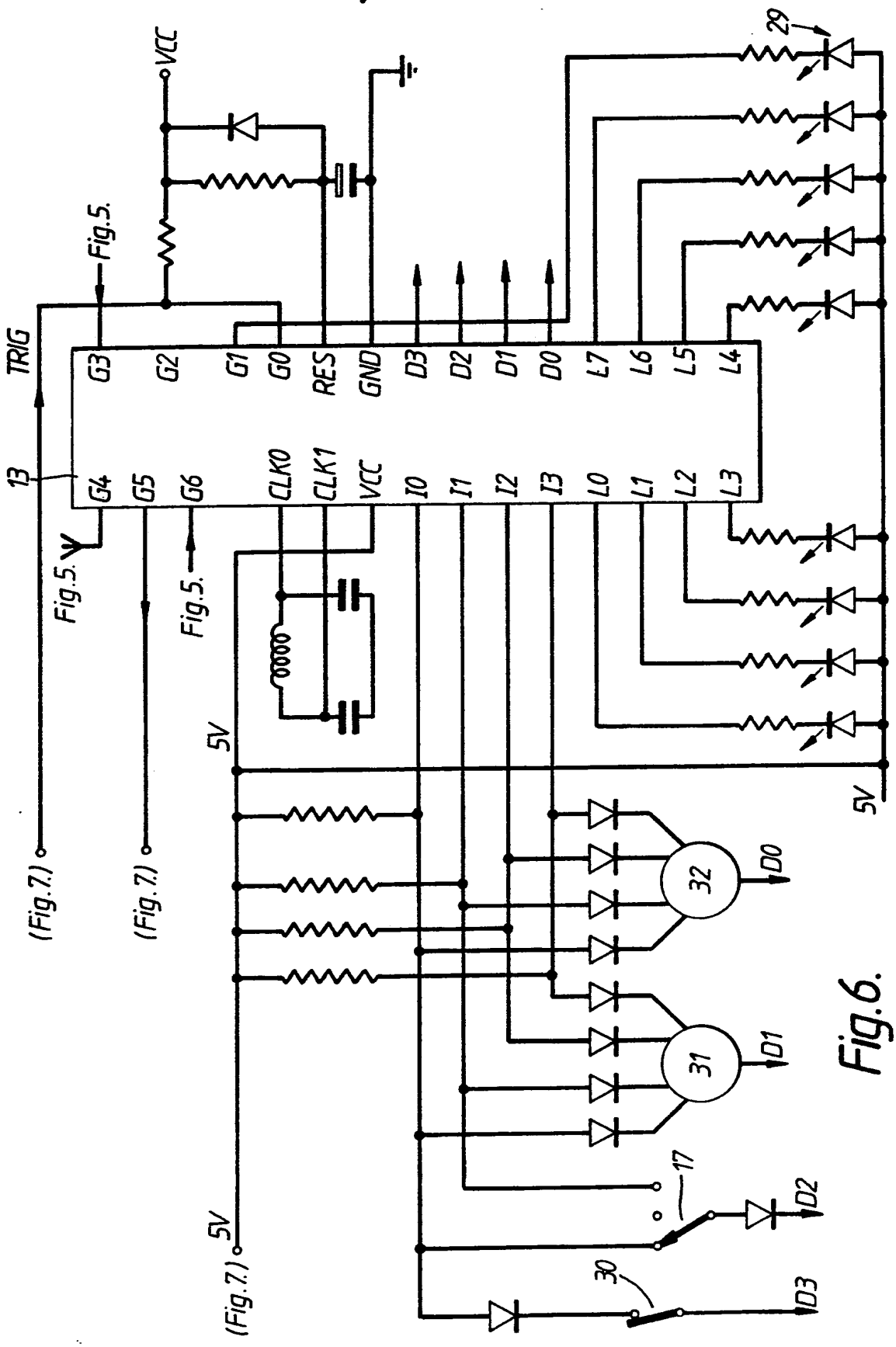
VCC
29
Fig.5.
TRIG
13
G3
G2
G1
G0
RES
GND
D3
D2
D1
D0
L7
L6
L5
L4
G4
G5
G6
CLK0
CLK1
VCC
I0
I1
I2
I3
L0
L1
L2
L3
Fig.5.
Fig.5.
5V
5V
(Fig.7.)
(Fig.7.)
(Fig.7.)
5V
32
D0
31
D1
17
D2
30
D3

Fig.6.

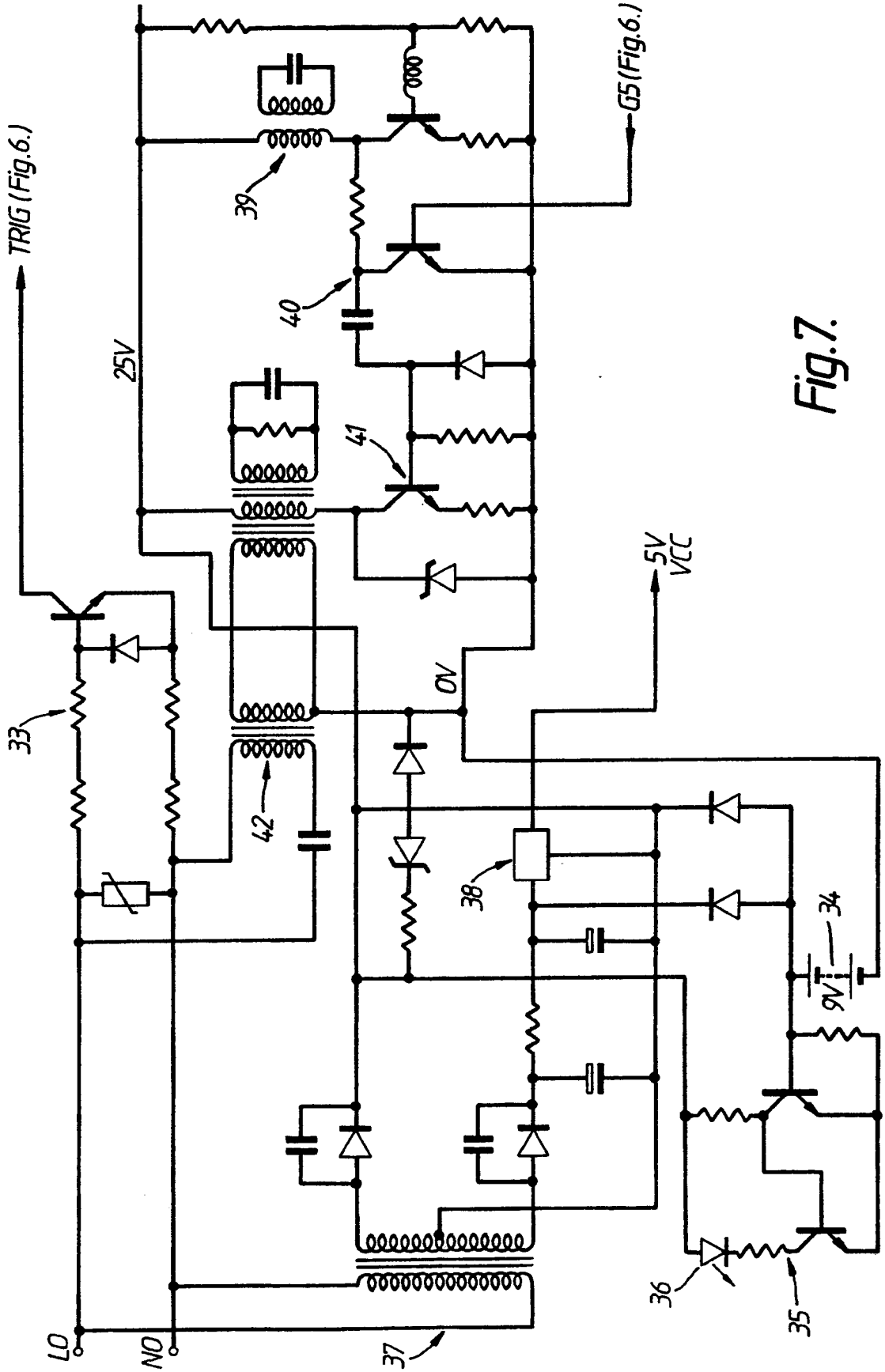
TRIG (Fig.6.)
G5 (Fig.6.)
25V
5V
VCC
0V
39
40
41
42
33
38
34
9V
36
35
37
LO
NO

Fig.7.

# REMOTE CONTROL SYSTEMS

## BACKGROUND OF THE INVENTION

This invention relates to remote control systems.

At present there are many systems on the market which involve a receiver and a number of remote transmitters for controlling the receiver. Examples of such systems are remote control garage door openers, alarm systems using radio as the means of communication between sensors (acting as transmitters) and a central control unit (receiver) and control systems using mains signalling. In order that one system does not interfere with neighbouring systems, it is usual to have a digital coding means unique to each system in that receivers only respond when a transmission includes a particular code or codes. The code is frequently set up using codewheels or multiple discrete switches. For the system to operate, these codes must be set identically on the or each receiver and on the or each transmitter. This can give rise to problems with non-technical users of the systems. Another problem which can arise is that the system is not immune from outside interference by someone persistent enough to go through the total number of code combinations (usually of the order of 500). This is particularly the case when the communications means is by radio, when no access is required to the premises housing the receiver.

## SUMMARY OF THE INVENTION

According to one aspect of the invention, there is provided a transmitter for a remote control system comprising:

means for storing an identity code;

means for generating a message including said identity code;

an input for receiving an external stimulus and coupled to the generating means to initiate message

generation;

means for transmitting said message; and

means operable to generate a random or pseudo-random number and to store that number as said identity code for use in message generation to inform a receiver of the generated code.

According to another aspect of the invention, there is provided a receiver for a remote control system, the receiver comprising:

means for storing an identity code;

an input for receiving a signal from a transmitter;

means for validating said signal by detecting if said identity code is contained in said signal;

means for putting the receiver into an installation mode; and

means responsive to said signal when the receiver is in said installation mode to obtain an identity code therefrom and for storing that code in the storing means for subsequent use by the validating means.

One embodiment comprises a remote control system operating by radio waves or other remote control signals and having a receiver unit and multiple transmitters, the transmitters having no mechanical means of setting digital security codes. The receiver has two modes of operation changeable by a switch on the receiver. In an 'Install' mode, the receiver accepts a plurality of security or identity codes received by it and has a memory to store those codes for future use. Each transmitter has means which will, on first application of power or on request, randomly generate its own security code, transmit that code and remember that code thereafter. Once all the transmitters have sent their codes to the receiver(s), the receiver(s) will be set to the other, normal, 'Run' mode. Only those transmitters which have been logged

in in this way will be recognised by the receiver(s). Since there is no way of manually stepping through the codes, outside interference is virtually impossible. It is apparent that each receiver and transmitter must be capable of remembering codes indefinitely, but this is easily achieved by use of backup batteries, or other means of non-volatile storage readily available in current semiconductor devices. A further advantage is that the only limit to the number of possible identity codes is the amount of memory available in the receiver(s) and in no way relies on the physical constraints of incorporating multiple mechanical switches.

DESCRIPTION OF THE FIGURES

As an example, reference may be made to the Figures of the accompanying drawings in which:

Figure 1 is a diagram of a transmitter/receiver system;

Figure 2 is a flow chart of a transmitter;

Figure 3 is a flow chart of a receiver;

Figure 4 is a circuit diagram of a transmitter;

Figure 5 is a circuit diagram of a receiver receiver-and-demodulate circuit and alarm circuit;

Figure 6 is a circuit diagram of the receiver of Figure 5; and

Figure 7 is a circuit diagram of the power supply and mains control signal circuitry of Figure 5.

DESCRIPTION OF PREFERRED EMBODIMENTS

In Figure 1, a plurality of transmitters 1 (one of which is shown in detail) and a receiver 2 are shown.

Each transmitter has means 3 of any of a variety of known structures for transmitting signal (e.g. a pulse code modulated radio signal). Means 3 is pulsed with data by a microprocessor system 4 comprising a microprocessor 5 and memory 6. The memory 6 includes electrically erasable, non-volatile memory 7 (at least

in the sense that a battery 8 can maintain the data in that memory) and read-only memory 9 containing program. A command device 10 (e.g. responsive to a switch or a sensed external condition) is coupled to the microprocessor system 4 which generates therefrom a digitally coded signal comprising a command, corresponding to the data from device 10, and an identifying code from the non-volatile memory 7. On first powering up the transmitter, or on actuating a switch 11, a section of the program acts as a code generator which generates a pseudo-random code, stores that code as an identifying code in the memory 7 and issues a digitally coded control signal including that identifying code.

The, or each, receiver contains a receiving means 12 for receiving the coded radio transmissions, coupled to a microprocessor system 13 comprising a microprocessor 14, a memory 15, also electrically erasable and non-volatile, able to store a plurality of transmitter codes, and a read-only memory 16 containing a program to act, inter alia, as a verifying means to verify that a received signal is valid, i.e. that it includes one of the stored codes in memory 15. Additionally, the microprocessor 14 has an input coupled to a switch 17. In one, normal, position of the switch, the receiver operates as described to verify or validate incoming signals and issue the corresponding command. In the other, "Install", mode it renders the receiver responsive to transmissions from all nearby transmitters which will be successively activated by the user to cause them to emit "messages" giving a definition of the random codes set up by the transmitters. During operation in this mode, each identity code sensed will be stored in the memory 15.

The operation of the transmitter can be summarised by the flow chart of Figure 2 representing the software

held in read-only memory 9.

Initially, the program tests to see whether or not a command is issued at device 10. If a positive result is detected, the program proceeds to extract the identity code and to generate a digitally coded message comprising: a start code, the identity code and the command or data code. The resulting message is then transmitted.

If the switch 11 is being actuated, then a new identity code is generated by a counter implemented in software. The counter will run whilst the switch 11 is being actuated and its resulting count will be transferred as the new identity code or value to the memory 7. The software will then proceeds to generate a message as before when a command is issued, i.e. a message comprising a start code followed by the new identity code now found in memory 7, together with the relevant command or data. It will be appreciated that this command has been issued merely for the purpose of causing transmission of a new identity code so its precise value is of no importance.

Figure 3 illustrates by flow chart the form of the software in the receiver. Initially when a message is received its format is checked with regard to certain criteria which will be described in more detail below in connection with a specific example. If the correct format is detected, then the software detects whether or not the receiver is in its "Install" mode, i.e. whether or not switch 17 is closed. If it is not closed, the system operates in its "Normal" mode in order to extract the relevant command.

In the "Normal" mode, the identity code is extracted from the message and then compared with all identity codes that are currently present in memory 15. If the identity code of the message is one of those stored codes, then the message is finally deemed to be

verified. The relevant command is then executed.

In the "Install" mode, the identity code is extracted from the message and stored in the receiver memory 15 where it is stored alongside a plurality of other identifying codes received from other respective transmitters.

With regard to the form of the digitally coded message, one example is as follows:

a) a start code consisting of a 9 ms block of carrier followed by a 4 1/2 ms gap;

b) 16 bits consisting of the eight bit identity code followed by eight further bits comprising the first four bits of the identity code followed by the inverse of the final four bits of the identity code; and

c) the command or data in the form of sixteen bits consisting of an eight bit command or data item followed by the first four bits of that item, finally followed by the inverse of the last four bits of that item.

It will be apparent that software can verify the status of the digitally coded message by comparison between the true and partially inverted forms of the sections (b) and (c) of the message.

Figure 4 shows a circuit diagram of the circuit of a transmitter. This transmitter can in practice take any of several forms which include a hand-held transmitter, having keys enabling the user to remotely control items such as domestic lighting and garage door motors, and security devices responsive to the opening and closing of windows and doors and to the response of other security devices. The circuit thus includes a series of switches 10 which are operable to cause the transmission of distinct messages. In one example, in this case a hand-held transmitter, the switches are, starting from the top, an "ARM" switch, a "DISARM"

switch, a "lights on" switch and a "lights off" switch. In another example, which may be a window or door alarm, these switches may be replaced by two switches coupled to send door/window "open" and "closed", respectively. In normal use, the transmitter will be coupled to a 9v battery which will provide a trickle charge to VCC via a potential divider 18, the trickle charge being sufficient to maintain the operation of a microprocessor system 4 (COP413C) incorporating the microprocessor 5 and memories 7 and 9. When any one of the switches 10 is activated, a transistor 19 is rendered conductive to activate a second potential divider 20 also providing VCC and having a considerably lower impedance, thus to provide ample current for the operation of the overall circuit. As a consequence, a reset signal will be provided to the RESET input of the microprocessor system 4, causing its internal program in memory 9 to commence. Also shown in this Figure is the switch 11 which initiates the generation of a new pseudo-random identity code and its transmission to a receiver. The digitally coded message is formatted by the program in the microprocessor system and emitted at output SO to the transmitter stage 3 comprising an oscillator at 310MHz which is pulsed on and off by the digitally coded signal by means of a transistor 21. The oscillator has an output antenna 22 incorporating a small wire loop at 23 which may be adjusted for the purposes of fine tuning.

It is additionally mentioned that there is a further switch 24 which, when closed, causes an additional bit to be transmitted in the digitally coded message. The purpose of this is for the mode of operation of a receiver to be switched from an instantaneous to a delay mode. Thus, when the system is used as a security system, the user can initiate a delay in this way to enable him to reset the various

transmitters, e.g. those on windows and doors, before the alarm aspects of the system become active.

Figure 5 shows the receiving means 12 of the receiver, in this case comprising a RF input stage 25 driving a super-regenerative receiver 26 the demodulated output of which is presented to three successive amplifying stages which produce the correct level for pin G6 (shown in Figure 6).

Figure 5 also shows an alarm circuit 27 comprising piezo-electric buzzer elements 28 in a transistorised driving circuit having two inputs coupled to terminals G4 and G2 (Figure 6). Input G4 provides an enabling signal to the alarm circuit and input G2 provides a pulsed input enabling the sound produced to be determined by microprocessor, e.g. to provide a two-tone alarm or various forms of warning "beeper".

Figure 6 shows the main circuitry of the receiver, comprising the microprocessor system 13 (COP840C). The microprocessor system controls a set of LEDs 29 providing a visual indication to the user of conditions in the system, i.e. as to whether the receiver is armed and whether or not specific windows or doors are open. These LEDs may be illuminated simultaneously with transmitting a characteristic beep to the alarm circuit 27. Figure 6 also illustrates the installation switch 17 shown in its installation position. In the middle position of that switch, the receiver runs in its Normal mode but with no warning beeps being given to the alarm circuit. In the right-hand position of switch 17, the receiver again runs in its Normal mode but will issue warning or indicating beep signals to the alarm circuit 27.

An accept switch 30 is additionally coupled to the microprocessor system 13. This button allows the user to override a failed alarm transmitter or to change between banks of transmitter devices. In this respect

it is noted that the capacity of the receiver is to store sixteen sensor transmitter identity codes and eight hand-held transmitter identity codes. The condition of any eight of these transmitters can be shown on eight of the LEDs 29 and the particular eight can be changed by actuation of switch 30.

The receiver additionally incorporates two rotary switches 32 each having sixteen positions in order to define a house code and a device code constituting the address of the specific lighting device that the receiver of this security system is able to control in response to a "lights on" or "lights off" signal from a hand-held transmitter. This control of the lighting device is by mains signalling in accordance with the system described in British Patent Specification No. 1592971 to which reference should be made for additional details. The relevant digitally coded signal for mains transmission is developed by the microprocessor system and emitted on output G5 which is coupled to the mains as shown in Figure 7.

Figure 7 shows the power supply and mains circuitry of the receiver. Coupled to the live and neutral terminals of the mains (L, N) is a circuit 33 providing a square wave (TRIG) derived from the mains to define its zero-crossings in order that the signal produced at terminal G5 should be correctly synchronised for mains transmission according to U.K. Patent Specification No. 1592971. 34 designates the back-up battery which enables the data in the memory 15 of the microprocessor system to be maintained in the event of power failure. A circuit 35 is coupled to the battery to detect low battery level at which time an LED 36 illuminates as a warning signal. Circuitry 37 provides step-down and rectification to provide the 5 volt and 25 volt supplies required by the receiver circuitry. In this circuit 37, 38 designates a 5v

regulator circuit.

Output G5 of the microprocessor system carries the envelope of the required code for the mains signalling system and this modulates a 120 KHz carrier created by an oscillator 39. Transistor 40 switches this carrier on and off in accordance with the data from output G5 and the resulting modulated carrier is supplied by an output stage 41 which applies the resulting signal to the mains via an isolating transformer 42.

CLAIMS:

1. A transmitter for a remote control system comprising: means for storing an identity code; means for generating a message including said identity code; means for transmitting said message; and means operable to generate a random or pseudo-random number and to store that number as said identity code for use in message generation to inform a receiver of the generated code.

2. A transmitter as claimed in claim 1, and comprising a microprocessor system to provide the message and number generating means.

3. A transmitter as claimed in claim 1 or 2, and comprising circuit means to provide back-up current from a battery to said storing means.

4. A transmitter as claimed in claim 1, 2 or 3, and comprising manually operable switch means coupled to initiate operation of the number generating means.

5. A transmitter as claimed in any one of claims 1 to 4, and comprising keys or switches to provide commands to initiate message generation and transmsission.

6. A receiver for a remote control system, the receiver comprising: means for storing an identity code; an input for receiving a signal from a transmitter; means for validating said signal by detecting if said identity code is contained in said signal; means for putting the receiver into an installation mode; and means responsive to said signal when the receiver is in said installation mode to obtain an identity code therefrom and for storing that code in the storing means for subsequent use by the validating means.

7. A receiver as claimed in claim 6, and comprising a microprocessor system to provide the validating and responsive means.

8. A receiver as claimed in claim 6 or 7, and comprising circuit means to provide back-up current from a battery to said storing means.

9. A receiver as claimed in claim 6, 7 or 8 wherein the storing means is operable to store a plurality of different identity codes and the validating means is operable to compare a received identity code with each stored identity code and to detect validity when any one stored identity code corresponds to the received identity code.

10. A receiver as claimed in any one of claims 6 to 9, and comprising alarm means and means to actuate the alarm means on receiving a validated signal containing a command of a predetermined form.

11. A receiver as claimed in any one of claims 6 to 10 and comprising transmission means for transmitting a command to an external device and means to activate the transmission means on receiving a validated signal containing a command of a second predetermined form.

12. A radio transmitter/receiver system comprising:

a transmitter having:

(a) an identity code store;

(b) means for inputting a command;

(c) means for generating a message comprising said stored identity code and said command;

(d) an output for transmitting said message;

(e) means for initiating an installation mode of operation;

(f) means responsive to the initiating means for generating a random number and storing it in the store for use in generating a message incorporating the stored random number; and

a receiver having:

(a) an input stage to receive said message;

(b) a store for storing a plurality of identity codes;

(c) means for validating said message by checking for correspondence between an identity code in said message and an identity code in said store;

(d) means for executing a command contained in the validated message;

(e) means for initiating an installation mode of operation of said receiver; and

(f) means responsive to said initiating means of the receiver whilst in said installation mode to extract identity codes from received messages and to store those codes in the receiver store.

13. A system as claimed in claim 12, wherein the output of the transmitter has means for modulating the message on an RF carrier and the input stage of the receiver comprises an RF receiving and demodulating means.

14. A transmitter or receiver or transmitter/receiver system substantially as hereinbefore described with reference to Figures 1 to 3, or Figures 2 to 7, of the accompanying drawings.